

NASA Advisory Council
Workshop on Science Associated with the Lunar Exploration Architecture
Detailed Program
February 27 - March 2, 2007

Tuesday, February 27, 2007

Opening Plenary, Galleria Ballroom
Overflow room: Encantada

8:00 a.m.	Opening remarks	B. Jolliff and H. Schmitt
8:15 a.m.	The Vision for Space Exploration	M. Griffin
8:45 a.m.	SMD: Science associated with the VSE	C. Hartman
9:00 a.m.	NRC Interim Report on the Scientific Context for Exploration of the Moon	C. Pieters G. Paulikas
9:30 a.m.	***** BREAK *****	
9:50 a.m.	ESMD General welcome & introduction	S. Horowitz
10:00 a.m.	Introduction of Global Exploration Strategy and Lunar Architecture Team	D. Cooke
10:10 a.m.	Global Exploration Strategy (including international and commercial components)	J. Volosin
10:50 a.m.	Overview and Status of the Lunar Exploration Architecture Team Activity	D. Cooke
11:00 a.m.	Science within the Lunar Architecture	T. Morgan / L. Leshin
11:30 a.m.	LEAG TOP-SAT: Summary of Results and Science Objectives	J. Taylor
12:15 p.m.	***** LUNCH *****	
	Subcommittee science discussion overviews (each SC gives a 20 min overview)	
1:30 p.m.	Astrophysics Overview	D. Spergel
1:50 p.m.	Heliophysics Overview	Harlan Spence
2:10 p.m.	Planetary Protection Overview	John Rummel
2:30 p.m.	Planetary Science Overview	Sean Solomon
2:50 p.m.	Earth Science Overview The Lunar Earth Observatory Concept	M. Ramsey P. Christensen
3:10 p.m.	***** BREAK *****	
3:30 p.m.	Subcommittee Breakout Sessions	

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Astrophysics Subcommittee, Prescott Room

3:30 p.m.	Astrophysics Introduction: Review of STScI Meeting	Session Chair: D. Spergel
3:40 p.m.	Astrophysics Enabled by the Return to the Moon Report	M. Livio
4:30 p.m.	Astrophysics Theme 1: IR/Optical/UV Telescopes	
4:40 p.m.	Dirt, Gravity, and Lunar-Based Telescopes: The Value Proposition for Astronomy	D. Lester
5:30 p.m.	Adjourn	

Tuesday, February 27, 2007

Earth Science Subcommittee, Palo Verde Room

Breakout Session 1 - NRC Decadal Survey Review

3:30 p.m.	Earth Science Decadal Survey	M. Freilich
4:30 p.m.	ESD Road Mapping Process	B. Cramer
5:30 p.m.	Adjourn	

Tuesday, February 27, 2007

Heliophysics Subcommittee, Payson Room

3:30 p.m.	Breakout Session 1 - Heliophysics Science of the Moon	Session Chair: J. Spann
3:40 p.m.	Lunar Electromagnetic/Plasma Environment	B. Lin
4:10 p.m.	Determining Lunar Crustal Magnetic Fields and their Origin	J. Halekas
4:40 p.m.	The Lunar Wake as a Unique Plasma Physics Laboratory	B. Farrell, to be presented by J. Halekas
5:30 p.m.	Adjourn	

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Planetary Protection Subcommittee, Galleria Ballroom

3:30 – 5:30 p.m.	Breakout Session 1 - Organic/Microbial Analyses + Experiments	Moderator: M. Voytek & C. Conley
	Theme 1: Overview of life detection methods and challenges	A. Steele
	Theme 2: Organic measurements on the lunar surface: 'Natural' and planned experiments	J. Dworkin
	Theme 3: The Urey Experiment with Planetary Protection Applications	J. Bada
	Theme 4: Organics in the Apollo Lunar Samples	C. Allen, J. Lindsay
5:30 p.m.	Adjourn	

Tuesday, February 27, 2007

Planetary Science Subcommittee, Encantada Ballroom

	Breakout Session 1 - Key Science Problems I	Moderators: J. Head / J. Taylor
3:30 – 5:30 p.m.	Theme 1: Impact history of the inner solar system	D. Kring, T. Swindle
	Theme 2: Exosphere	A. Stern (by telephone)
	Theme 3: Nature, Origin and evolution of volatile polar deposits	D. Lawrence, B. Bussey
	Theme 4: Indigenous lunar volatiles	M. Rutherford
5:30 p.m.	Adjourn	

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8:00 a.m. Posters can be placed on display, Galleria Ballroom

Wednesday, February 28, 2007

APS, Prescott Room

8:30 **Breakout Session 2(a) - Astrophysics Theme 2: Talk, Radio** **Session Chair: J. Mather**

8:50 a.m. The 21cm Background: A Low-Frequency Probe of the
High-Redshift Universe J. Hewitt

9:30 a.m. Peering through the Dark Ages with a Low Frequency Telescope
on the Moon J. Burns

9:50 a.m. Radio Wavelength Observatories and the Exploration Architecture J. Lazio

10:15 a.m. ***** BREAK*****

10:30 a.m. **Breakout Session 2(b) - Astrophysics Theme 1: High Energy
Astrophysics** **Session Chair: K. Flanagan**

10:40 a.m. High Energy Gamma-Ray and Cosmic-Ray Astrophysics on the Moon R. Binns

12:00 noon ***** LUNCH*****

Wednesday, February 28, 2007

ESS, Palo Verde Room

Breakout Session 2(a) –Earth Science Decadal Survey Discussion

8:30 a.m. ESS Decadal Review Discussion: All
Which activities could map to a future lunar
Earth Observatory? Earth Science Decadal Survey

10:00 a.m. ***** BREAK*****

Breakout Session 2(b) - A Lunar-Based Earth Observatory Session Chair: M. Ramsey

10:15 a.m. Introduction M. Ramsey

10:30 a.m. A Lunar Earth Observatory P. Hamill

10:50 a.m. Dual-use Earth Science and Lunar Exploration missions T. Freeman

11:10 a.m. Science Observations from the Earth-Moon L1 Point J. West

11:30 a.m. Panel Discussion/Q&A All
(Ramsey, Freeman, Hamill, Christensen, West)

12:00 noon ***** LUNCH*****

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HPS, Payson Room

8:30 a.m.	Breakout Session 2(a) - Space Weather, Safeguarding the Journey	Session Chair: N. Schwadron
8:30 a.m.	Characterizing the Near Lunar Plasma Environment	T. Stubbs
9:00 a.m.	Dusty plasma issues on the lunar surface: Existing observations and required future measurements	M. Horanyi
9:30 a.m.	Space Weather Imaging from the Moon	Donald Hassler
10:00 a.m.	***** BREAK*****	
10:15 a.m.	Breakout Session 2(b) - Space Weather, Safeguarding the Journey	Session Chair: N. Schwadron
10:30 a.m.	Space Weather impacts on robotic and human productivity	J. Mazur
11:00 a.m.	Characterize radiation bombardment	J. Adams
11:30 a.m.	Systems on the lunar surface to support of Space Weather	J. Davila
12:00 noon	***** LUNCH*****	

Wednesday, February 28, 2007

Joint PSS-PPS, Encantada Ballroom

8:30 a.m.	Breakout Session 2 - Key Science Problems II	Moderators: C. Neal / C. Shearer
.	Theme 1: Differentiation History of the Terrestrial Planets as recorded on the Moon	L. Borg
	Theme 2: Structure and Evolution of the Lunar Interior	B. Banerdt, L. Hood
	Theme 3: Origin and Evolution of the Earth-Moon System	K. Righter
10:15 a.m.	***** BREAK*****	
10:30 a.m.	Theme 4: Evolution of the Lunar Crust	B. Jolliff, L. Nyquist
	Theme 5: Science associated with Resource Identification and Development	J. Taylor, M. Duke
	Theme 6: Surface Processes On Airless Planetary Bodies	L. Taylor
12:00 noon	***** LUNCH*****	

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APS, Prescott Room

1:30 p.m.	Astrophysics Theme 3: Fundamental Physics and Astronomy	Session Chair: C. Hogan
1:40 p.m.	Fundamental Physics from Lunar Ranging	T. Murphy
2:20 p.m.	ALIVE: An Autonomous Lunar Investigation of the Variable Earth	M. Turnbull
2:50 p.m.	Science and Astrobiology from the Moon or near Moon.	N. Woolf
3:00 p.m.	***** BREAK*****	
3:30 p.m.	Astrophysics Theme 4: Astrophysics Quodlibet	Session Chair: M. Cherry
3:40 p.m.	Enabling Astrophysics at the Moon	Y. Pendleton
3:50 p.m.	A Large Optical/UV Serviceable Space Telescope	M. Postman
3:00 p.m.	Large Optics in Space	P. Stahl
2 min/ea	Poster previews	poster presenters

Wednesday, February 28, 2007

ESS, Palo Verde Room

Breakout Session 3(a) - Land Imaging and Solid Earth Science

1:30 p.m.	Introduction	B. Minster
1:40 p.m.	Visible/Near-Infrared Remote Sensing of Earth From the Moon	J. Johnson
2:00 p.m.	Land Surface Monitoring from the Moon	J. Mustard
2:20 p.m.	Thermal Infrared Data from the Moon: Hazards and Hot-Spots	M. Ramsey
2:40 p.m.	Lunar-based Large Baseline Synthetic Aperture Radar Interferometry of Earth	K. Sarabandi
3:00 p.m.	Panel Discussion/Questions & Answers (Minster, Johnson, Mustard, Ramsey, Sarabandi)	All
3:15 pm	***** BREAK*****	

Breakout Session 3(b) - Atmospheric Composition and Climate

3:30 p.m.	Introduction	D. Jacob
3:40 p.m.	Lunar Observations of Changes in the Earth's Albedo (LOCEA)	A. Ruzmaikin

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4:00 p.m.	Observations of Lightning on Earth from the Lunar Surface	S. Goodman
4:20 p.m.	Variability in Global Top-of-Atmosphere Shortwave Radiation	N. Loeb
4:40 p.m.	Panel Discussion/Questions & Answers (Jacob, Herman, Goodman, Loeb, Ruzmaikin)	All
5:30 p.m.	***** ADJOURN*****	

Wednesday, February 28, 2007
HPS, Payson Room

1:30 p.m.	Breakout Session 3(a): The Moon as a Historical Record	Session Chair: D. McKay
1:40 p.m.	Composition of the Solar Wind	S. Suess
2:00 p.m.	History of the Sun and Cosmic Radiation	K. Marti
2:20 p.m.	History of the Local Interstellar Medium	D. McKay
2:40 p.m.	History of Inner Solar System According to Lunar Cold Traps	D. Crider
3:00 p.m.	***** BREAK*****	
3:30 p.m.	Breakout Session 3(b): The Moon as a Heliophysics Science Platform	Session Chair: A. Christensen
4:00 p.m.	Ionosphere/Magnetosphere imaging	D. Gallagher
4:30 p.m.	The Moon as a base for Solar Observations	G. Emslie
5:00 p.m.	Solar Observations associated with the Return to the Moon	A. Title
5:30 p.m.	***** ADJOURN*****	

Wednesday, February 28, 2007
Joint PSS-PPS, Encantada Ballroom

	Breakout Session 3a - Implementation of Key Science into Lunar Exploration	Moderators: C. Shearer
1:30 p.m.	Theme 1: Important Scientific Sites on the Moon	J. Head
.	Theme 2: Lunar Architecture's Plans to provide Access to Science Sites	All, LAT – discussion
	Theme 3: Geophysical Networks	C. Neal
	Theme 4: Importance of Sample Science and Sample Return	C. Shearer

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Theme 5: The Need for Integrating Planetary Protection Science and Technology M. Race

3:15 pm

***** BREAK *****

Breakout Session 3a - "Implementation of key science into the exploration of the Moon and Mars"

Moderators: N. Budden / L. Borg

3:30 p.m.

Theme 1: Human Surface Science

H. Schmitt

Theme 2: Human-Robotic Combined Activities in Accomplishing Science

P. Spudis

Theme 3: Linkages between the Moon and Mars

D. Beaty

Theme 4: EVA Suit Competency for Science: Capabilities and Contamination

D. Eppler, J. Lindsay

Theme 5: The AMASE Effort and Planetary Exploration

A. Steele

5:30 p.m.

***** ADJOURN *****

Wednesday, February 28, 2007

Outreach, Ponderosa

3:40--5:30 p.m.

Outreach I

G. Kulcinski

4:00 p.m.

Lunar Exploration Outreach Program

K. Erickson

4:45 p.m.

Lunar Reconnaissance Orbiter Outreach

S. Stockman

5:30 p.m.

***** ADJOURN *****

Wednesday, February 28, 2007

Poster session, Galleria Ballroom

6:00 p.m.

Poster session open

Cash bar, light snacks

8:00 p.m.

Poster session closes, posters must be removed

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Thursday, March 1, 2007

Plenary Session, Galleria Ballroom

8:15 a.m.	Introduction to Cross-cutting Topics, Thursday Agenda	B. Jolliff
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Thursday, March 1, 2007

Exploration Science (Environment, Resources, Poles), Encantada

Breakout Session 4 - "Exploration Science"

Moderators: M. Duke / A. Steele

9:00 a.m.	Theme 1: ISRU Program Overview, including Timing	W. Larson
	Theme 2: Effects of ISRU on the Lunar Environment	R. Vondrak
	Theme 3: Space Weather	N. Schwadron
10:15 a.m.	***** BREAK *****	
	Theme 4: Physical / Chemical Properties and Potential Toxicity of Lunar Dust	L. Taylor
	Theme 5: Lunar Planetary Protection Testbeds and Life Support for Mars exploration	J. Rummel
	Theme 6: Astrobiology and Lunar Exploration	A. Anbar
12:00 noon	***** LUNCH *****	

Thursday, March 1, 2007

Sun-Earth Interactions, Payson

Breakout Session 4 – Sun-Earth Interactions

Moderators: A. Christensen / K. Steffen

9:00 a.m.	Sun's Role in Climate Change	P. Goode
9:20 a.m.	A Possibility to Recover the Past Solar Constant (TSI) with the Moon	K. Steffen
9:40 a.m.	Imaging the Sun from the Moon	E. Deluca
10:15 a.m.	***** BREAK *****	
10:30 a.m.	Lunar JANUS Mission: An Exploration of the Earth and Sun	J. Herman
10:50 a.m.	Imaging the Earth from the Moon	M. Turnbull
11:10 a.m.	Imaging Earth from the Moon	L. Paxton
	Panel Discussion, summarize key points	All
12:00 noon	***** LUNCH *****	

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Thursday, March 1, 2007
Lunar Dust Science, Palo Verde

Breakout Session 4 – Lunar Dust Science

Moderator: D. Winterhalter

9:00 a.m.	Introduction to Lunar Dust Science and Overview of the NESC Dust Workshop	D. Winterhalter
9:15 a.m.	Everything You Ever Wanted to Know about Lunar Dust	L. Taylor
9:35 a.m.	Interaction of Dust and Plasma on the Moon and Exosphere	T. Stubbs
9:55 a.m.	Measuring and Modeling the Plasma Environment	Z. Sternovsky
10:15 a.m.	***** BREAK*****	
10:30 a.m.	Dust Analysis at the Moon	Y. Pendleton
10:50 a.m.	Microwave Magnetic Properties of Dust and Its implication for Geophysics and Cohesion	X. Yu
11:10 a.m.	Lunar Dust Distributions from Solar Infrared Absorption Measurements with a Fourier Transform Spectrometer	M. Abbas
11:30 a.m.	Autonomous Lunar Dust Observer for the Systematic Study of natural and Anthropogenic Dust Phenomena on Airless Bodies	C. Grund
	Panel Discussion, summarize key points – All	
12:00 noon	***** LUNCH*****	

Thursday, March 1, 2007
Science potentially enabled, but not within initial scope, Prescott

Breakout Session 4 – Science potentially enabled, but not within initial scope

Moderator: J. Mather

9:00 a.m.	Heliophysics low frequency radio astronomy	Justin Kasper
9:20 a.m.	Synergies between Solar and Celestial Radio Astronomy”	J. Hewitt
9:50 a.m.	In-Space capabilities fostered by the return to the Moon	H. Thronson
10:15 a.m.	***** BREAK*****	
10:30 a.m.	Costing Space and Lunar missions	D. Ebbets
10:50 a.m.	Enabling large space optics: SAFIR human and robotic development	T. Espero
	Panel Discussion, summarize key points – All	
12:00 noon	***** LUNCH*****	

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Thursday, March 1, 2007
Outreach, Ponderosa

9:00 a.m. - 12:00 noon **Outreach II**

Session Chair: G. Kulcinski

Thursday, March 1, 2007
Plenary Session, Galleria Ballroom

1:30 p.m.	Reports of Special Topics Breakouts	B. Jolliff
1:35 p.m.	Exploration Science	L. Taylor / A. Steele
1:50 p.m.	Sun-Earth Interactions	A. Christensen/ K. Steffen
2:05 p.m.	Lunar Dust Science	D. Winterhalter
2:20 p.m.	Science Potentially Enabled, but not within Initial Scope	J. Mather
2:35 p.m.	Outreach	G. Kulcinski
2:50 p.m.	Introduction to Prioritizing the Science Objective Lists	B. Jolliff
3:00 p.m.	***** BREAK*****	
3:30 – 5:30 p.m.	Subcommittee Breakouts, Session 5	

Each of the Subcommittees will be asked to revisit the “Science Objectives Decomposition” matrix for their specific expertise and to use the remaining afternoon breakout sessions to prioritize the objectives and to provide any additional comments or recommendations regarding the listed objectives and implementation issues. This is also the time for subcommittees to prepare a summary of findings and recommendations for the closing plenary session on Friday morning.

Thursday Afternoon Breakout Session Locations:

Astrophysics Subcommittee, Prescott

Earth Science Subcommittee, Palo Verde

Heliophysics Subcommittee, Payson

Planetary Protection Subcommittee, Galleria

Planetary Science Subcommittee, Encantada

Outreach Committee, Ponderosa

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Friday, March 2, 2007

Closing Plenary, Galleria Ballroom

8:30 a.m.	Closing Plenary, Reports of Subcommittees, Lunar Architecture Team Remarks	B. Jolliff
8:40 a.m.	APS findings, recommendations	J. Mather
9:00 a.m.	ESS findings, recommendations	M. Ramsey
9:20 a.m.	HPS findings, recommendations	R. Torbert
9:50 a.m.	PPS findings, recommendations	J. Rummel
10:15 a.m.	***** BREAK*****	
10:30 a.m.	PSS findings, recommendations	S. Solomon
10:50 a.m.	Outreach Committee	G. Kulcinski
11:10 a.m.	Lunar Architecture Team Remarks	D. Cooke, G. Yoder
11:30 a.m.	Conclude Workshop	B. Jolliff / H. Schmitt
12:00 noon	***** LUNCH*****	
1:30 p.m.	Synthesis Group – Payson Room Synthesis committee reconvene Determine organization & format of final report Synthesis committee writing assignments Plan timeline for completion, review, and delivery of final product to NAC LEAG: Future activity related to the Lunar Exploration Architecture Discuss Workshop Summary Report for EOS (AGU Newsletter)	
4:00 p.m.	Adjourn	B. Jolliff / C. Neal C. Neal N. Budden

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Poster Presentations

<u>First Author</u>	<u>Title</u>
Abell	Scientific exploration of near-earth objects via the crew exploration vehicle.
Adams	Orbiting Astrophysical Spectrometer in Space (OASIS)
Anbar	Lunar surface instrumentation for sample selection
Archinal	Urgent processing and geodetic control of lunar data
Baker	Applying near-surface geophysical technology to determine engineering properties of the upper 30m of the lunar surface
Bicay	The promise of lunar science with small spacecraft
Bottke	The late heavy bombardment of the Moon: A prospectus
Byrne	Interior of the Near Side Megabasin of the Moon
Christensen	Finding terrestrial rocks and other "exotic" materials on the lunar surface
Clark	Robotic mobility enhancement: Tetrahedral rovers
Clark	Finding a dust mitigation strategy for lunar surface operations
Clegg	Lunar elemental analysis with remote laser induced breakdown spectroscopy (LIBS)
Cooper	Identification of lunar organic compounds and their sources
Ebbets	A large telescope can be enabled by NASA's lunar exploration architecture
Ebbets	Cost considerations for astronomy at a lunar base
Elphic	How do we prospect for ice at the Moon's south pole?
Farrell	The lunar wake as a unique plasma physics laboratory
Fries	Moonraker: Promise and limitations of a concept for grain-wise mineralogical characterization of lunar regolith using raman spectroscopy
Garrick-Bethel	Lunar magnetism studies by crewed missions to the Moon
Garry	Mobile Agents Architecture: Voice-commanded EVA system to assist Astronauts with scientific exploration on the Moon and preparation for future Mars missions
Glavin	Volatile Analysis by Pyrolysis of Regolith (VAPoR) on the Moon using Mass Spectrometry
Gruener	Developing Science Objectives in the Context of an Operational Concept for Lunar Surface Exploration
Gruener	Surface Mobility as a Key Capability to Accomplishing Lunar Science Objectives: A South Pole Example
Hammel	Piggyback Instrumentation on Lunar Orbital Surveyors for Characterizing Zodiacal Dust within 1 AU of the Sun
Hare	Lunar Geographic Information Systems (GIS) for Dataset Synthesis and Analysis
Hassler	Space Weather Imaging from the Moon
Heldmann	Return to the Moon: Site Selection Process and Considerations for NASA's Lunar Exploration Program
Horanyi	The Lunar Dust Observatory
Kilston	Micrometeoroid characterization in the near-lunar environment
Kring	A Rover-based Strategy for the Robotic and Human Phases of the Lunar Exploration Initiative
Kruger	Determination of Lunar Regolith Thickness and Exploration for Frozen Lunar Water Using Human-Operated Ground-Penetrating Radar
Kuhlman	High-Fidelity Lunar Regolith Simulants: Synergies Between Lunar Exploration and Lunar Science
McCubbin	The Search for Water in Igneous Lunar Materials: A Re-Assessment of the Lunar Magmatic Volatile Budget
Messmer	Numerical Simulations of the Lunar Plasma environment with the VORPAL framework
Milam	Some Thoughts on Lunar Excavation
Naji	Half-Month Solar Thermal and Electric Storage System for a Lunar Environment
Prufert	Utility of Microbes in Space: Revisited
Rice	Astronaut Lunar Field Exploration Training
Spence	Heliophysics and Lunar Science Goals of NASA's Cosmic Ray Telescope for the Effects of Radiation Aboard the Lunar Reconnaissance Orbiter
Stoker	The Scientific Rationale and Technical Approach for Drilling on the Moon and Mars
Van Cleve	Preparing the Ground for a Helium-3 Economy from a Polar Lunar Outpost
Weinberg	Global Lunar Geophysical Science
Zawodny	Quantifying the Processes that Control the Distribution of Dust in the Moon's Atmosphere

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Print Only White Papers

<u>First Author</u>	<u>Title</u>
Adams	The Ionizing Radiation Environment for Exploration
Allen	Sample curation at a lunar outpost
Buehler	In situ mapping the lunar surface and subsurface
Brandt	Imaging of the Heliospheric Boundary
Crawford	Exploring the basaltic lava flows of Oceanus Procellarum: Valuable (nonpolar) lunar science facilitated by a renewed human presence on the Moon
Edwards	Automated Lunar Surface Reconstruction From Orbital Imagery
Freund	Large impact-generated current pulses and a re-evaluation of the magnetic signature around lunar impact craters
Goodman	Observations of Lightning on Earth from the Lunar Surface
Grimm	Dielectric spectroscopy mapping of subsurface ice on the Moon
Harrison	The Oldest Earth and Moon Rocks
Hollerman	Generation of Measurable Current Caused by Lunar Impacts
Johnson	Development of the Raman/Champ instrument for lunar resource identification
Levine	Quantifying the Impact of Human Activities on the Density, Structure and Chemical Composition of the Moon's Atmosphere
Lewis	Integrating Science Payloads within the Lunar Transportation Architecture: Results of the NASA CEV Unpressurized Cargo Study - The User Case
Lewis	Laying the Foundation: Science Requirements for Lunar Outpost Site Analysis
Maule	Rapid On-site Science Operations and Human-Robot Interactions at Lunar and Mars Analogue Sites
McNamara	Concepts and Benefits of Lunar Core Drilling
Nozette	The strategic value of robotic precursors to human lunar polar exploration
Ozima	Comparative study of near- and far-side lunar soils: Toward the understanding early evolution of the Earth.